Demand for Nonalcoholic Beverages: The Case of Low-Income Households

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ABSTRACT

Household beverage consumption is investigated using data from the National Food Stamp Program Survey conducted in the United States. A censored Translog demand system is estimated with the full-information maximum-likelihood procedure. All own-price effects are negative and significant, and whole milk, reduced-fat milk, juice, coffee, and tea are found to be net substitutes for soft drink. Thus, prices provide a partial answer to the declining consumption of milk and rising consumption of soft drink. Nutrition information and dietary beliefs also play important roles, highlighting the importance of an effective nutrition education program directed toward the low-income households. [JEL citation: C34 (Truncated and Censored Models), D12 (Consumer Economics: Empirical), Q18 (Agricultural Policy; Food Policy).] © 2004 Wiley Periodicals, Inc.

1. INTRODUCTION

There have been major changes in beverage consumption in the United States. Per capita consumption of carbonated soft drink more than doubled from 1970 to 1999, while milk consumption declined by 24% during the same period (Putnam & Allshouse, 1999; USDA, 2002a,b). On a given day, the proportion of individuals consuming milk declined from 70% in 1977–1978 to 54% in 1994–1998 (Table 1). Among the consuming individuals, average daily consumption of milk declined from 13.9 fluid ounces in 1977–1978 to 12.2 fluid ounces in 1994–1998. During the same period, the proportion of individuals drinking carbonated soft drink on a given day increased from 33% in 1977–1978 to 50% in 1994–1998, with average consumption increasing from 15 to 23 fluid ounces per day.

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TABLE 1. Beverage Consumption Between 1977–1978 and 1994–1998

	1977–1978		1994–1998	
	% Consuming each day	Amount per day	% Consuming each day	Amount per day
Milk	69.8	13.9	53.7	12.2
Carbonated soft drink	32.8	15.4	50.1	23.2
Juice drink	13.5	13.0	20.0	17.1
Juice	30.3	7.7	28.5	11.3

Note. The sources of this data are Nationwide Food Consumption Survey 1977–1978 and Continuing Survey of Food Intakes by Individuals, 1994–1996, 1998.

Among the popular beverages consumed in the United States, milk is a rich source of calcium and vitamins A and D, while soft drink contains very little of these nutrients. A notable proportion of the U.S. population fail to meet the recommended calcium intake (Institute of Medicine, 1997). Higher intake of dietary calcium increases peak bone mass and delays the onset of bone fracture later in life (USDHHS, 1988). Improved diet is estimated to save $5.1 to $10.7 billion each year in medical care costs, missed work, and premature deaths associated with osteoporosis-related hip fractures (Barefield, 1996). Therefore, the declining trend in milk consumption and increasing trend in soft drink consumption have been a source of concerns in the United States.

One recent study has examined beverage consumption in the United States. Harnack, Stang, & Story (1999), using data from the U.S. Department of Agriculture's (USDA) 1994 Continuing Survey of Food Intakes by Individuals (CSFII), investigated the probability of consuming soft drink among children and adolescents as well as the association among the consumption of milk, soft drink, and fruit juice. Results of discrete-choice analysis suggest that soft drink displaces milk and fruit juice, particularly at high levels of soft drink consumption. One shortcoming in this study is that quantitative information is not utilized in the binary analysis. Further, the CSFII does not contain price information and, therefore, the roles of relative prices are completely ignored. Yet, data from the Bureau of Labor Statistics suggest that price of milk has risen since 1978 relative to price of soft drink (Figure 1; BLS, 2003). Have price changes caused the displacement of milk by soft drink and, if so, to what extent? Do demographic characteristics or behavioral factors play a role in beverage consumption? This study investigates the effects of economic factors (prices and expenditure), demographic characteristics, nutrition information, and dietary beliefs in beverage consumption. We use data from a recent food consumption survey for low-income households conducted in the United States, which allow estimation of a system of demand equations.

One data feature encountered in the current study is that the dependent variables (beverage expenditures) contain notable portions of zero values. As is well known, statistical procedures not accounting for such zero observations produce inconsistent parameter estimates. There exist a number of censored system estimators to accommodate such a data feature: the maximum-likelihood (ML) procedures of Amemiya (1974), Lee & Pitt (1986), Wales & Woodland (1983), and the two-step (TS) procedures of Heien & Wessells (1990), Perali & Chavas (2000), and Shonkwiler & Yen (1999). Two-step estimators are known to be statistically inefficient, while until recently ML estimation of large censored systems

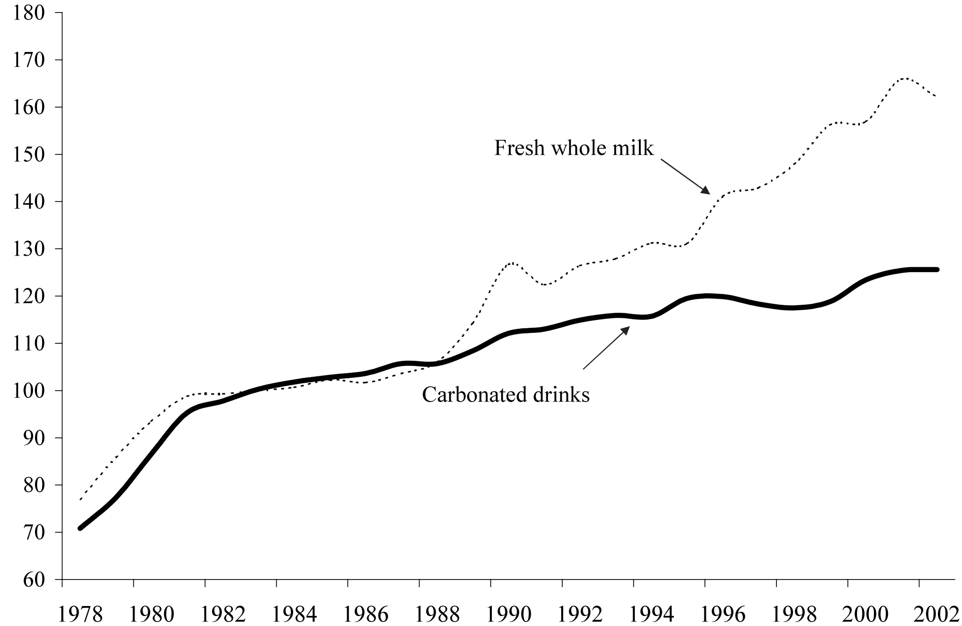

Figure 1 Relative price of beverages in the United States. Consumer price index for urban consumers (1982–1984 = 100).

has been hindered by the need to evaluate multiple probability integrals.[1] In this study, we estimate a Translog demand system using a nonlinear extension to the linear Tobit system of Amemiya (1974). Direct ML estimation is possible for the small system considered.

2. THE TRANSLOG DEMAND SYSTEM

This study focuses on household consumption of beverages so these products are assumed to be weakly separable from all other goods. Our empirical application is based on the Translog demand system, with demand share equations (Christensen, Jorgensen, & Lau, 1975)

$$s_i = \frac{\alpha_i + \sum_{j=1}^{n} \beta_{ij}(p_j/m)}{\sum_{j=1}^{n} \alpha_j + \sum_{k=1}^{n}\sum_{j=1}^{n} \beta_{kj}\log(p_j/m)}, i = 1,2,\ldots,n, \tag{1}$$

where p_j $(j = 1, 2, \ldots, n)$ are prices, m is total beverage expenditure, and α's and β's are parameters. Homogeneity is implicit in (1), and the symmetry restrictions are imposed:

$$\beta_{ij} = \beta_{ji} \ \forall \ i, j.$$

[1]Recent development in simulation estimation (Hajivassiliou, McFadden, & Ruud, 1996) resolves some of the computational issues with multiple probability integrals.

Demographic variables d_k are incorporated in the demand equations (1) by parameterizing α_i such that

$$\alpha_i = \alpha_{i0} + \sum_k \alpha_{ik} d_k,\ i = 1,2,\ldots,n,$$

where α_{i0} and α_{ik} are parameters to estimate. A convenient normalization rule is

$$\sum_{i=1}^{n} \alpha_{i0} = -1, \sum_{i=1}^{n} \alpha_{ik} = 0\ \forall\ k,$$

which guarantees adding-up of the deterministic system (1). Denote the vector of all parameters as θ and append an error term ε_i to each deterministic share, then the stochastic system is

$$w_i^* = s_i(\theta) + \varepsilon_i,\ i = 1,2,\ldots,n. \tag{2}$$

3. CENSORING AND THE LIKELIHOOD FUNCTION

In reality, the consumer choice is subject to nonnegativity constraints of quantities, and therefore observed consumption levels are subject to censoring. A number of statistical procedures exist in the literature that accommodate censored dependent variables in a consumer demand system (Lee & Pitt, 1986; Wales & Woodland, 1983). The approach used in this study is a nonlinear generalization of the linear Tobit system (Amemiya, 1974). In this approach, observed shares w_i relate to latent shares w_i^* such that

$$w_i = \max\{w_i^*, 0\},\ i = 1,2,\ldots,n. \tag{3}$$

Note that, due to censoring, the adding-up restriction does not hold for observed expenditure shares. To accommodate the adding-up restriction we estimate the first n–1 equations ($i = 1,2,\ldots,n-1$) in the system (3). Demand elasticities for the nth good are calculated using the identity $w_n = 1 - \sum_{i=1}^{n-1} w_i$.

Consider, without loss of generality, a regime in which the first ℓ goods are consumed, with observed (n–1)-vector $w = [w_1^*,\ldots,w_\ell^*,0,\ldots,0]'$. Denote the random error vector as $\xi \equiv [\xi_1', \xi_2']'$, partitioned such that $\xi_1 \equiv [\varepsilon_1,\ldots,\varepsilon_\ell]'$ and $\xi_2 \equiv [\varepsilon_{\ell+1},\ldots,\varepsilon_{n-1}]'$, and assume ξ is distributed as (n–1)-variate normal with zero mean and covariance matrix $\Sigma \equiv [\rho_{ij}\sigma_i\sigma_j]$, where ρ_{ij} are error correlation coefficients and σ_i are the error standard deviations. Denote $u \equiv [-s_{\ell+1}(\theta), -s_{\ell+2}(\theta),\ldots,-s_{n-1}(\theta)]'$. Then, the regime-switching condition for the aforementioned observed outcome (w) is

$$\xi_2 \leq u,$$

from which the likelihood contribution can be constructed as

$$L_c(w) = f(\xi_1) \int_{\{\xi_2 : \xi_2 \leq u\}} g(\xi_2|\xi_1) d\xi_2, \tag{4}$$

where $\xi_1 = [w_i - s_i(\theta)]$ is an ℓ-vector, $f(\xi_1)$ is the marginal density of ξ_1, and $g(\xi_2|\xi_1)$ is the conditional density of ξ_2 given ξ_1. The sample likelihood function is the product of the likelihood contribution (4) across the sample.

Censoring of the dependent variables should be accommodated when calculating demand elasticities. For commodity i, the unconditional mean of w_i is

$$E(w_i) = \Phi[s_i(\theta)/\sigma_i]s_i(\theta) + \sigma_i \phi[s_i(\theta)/\sigma_i], \tag{5}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are univariate standard normal probability density and cumulative distribution functions, respectively (Maddala, 1983). Demand elasticities are derived by differentiating (5).

4. DATA

Data for the current application are drawn from the National Food Stamp Program Survey (NFSPS), conducted by Mathematica Policy Research, Inc. for USDA's Food and Nutrition Service. The objectives of the survey were to assess the quality of the Food Stamp Program (FSP) customer service offered to the current and potential clients, to gain a perspective on the food shopping opportunities of FSP participants and other low-income households, and to examine the food security of FSP participants (Cohen et al., 1999).

The NFSPS collected data from a nationally representative sample of FSP participants between June 1996 and January 1997. An initial, computer-assisted interview collected information from each respondent on experience with the FSP, food shopping practices, expenditures on food at home and away from home, dietary knowledge and attitudes, and household demographics. A second, in-person interview, was conducted seven or more days after the initial contact. At this interview, the computer-assisted instrument was used to collect meal patterns and shopping trips during the previous 7 days. A list-assisted, paper and pencil instrument was used to collect household food use during the previous 7 days. This instrument recorded both the quantities and expenditures of food used over the period. The NFSPS is the only USDA survey in which household food use (quantity and expenditure) data have been collected since the 1987–88 Nationwide Food Consumption Survey. In total, 1,109 interviews were completed from the sample frame, and 1,069 households provided complete information on quantity and expenditure data. After excluding households with missing information on certain household characteristics, 908 households are included in the final sample for this study.

The beverages included in this study are whole milk, reduced-fat (2%, 1%, and skim) milk, juice (100% fruit and vegetables), soft drink, and coffee and tea. Soft drink includes carbonated soft drink as well as juice drink containing no more than 10% of juice. Besides prices, a number of other explanatory variables are included in the demand equations. First, a nutrition information variable is constructed as the sum of sources of nutrient and diet information, the information sources including newspapers, TV, or radio, the WIC program, advertisements, product labels, stores or supermarkets, and schools. Construction of such an information variable is common in the health-care and consumer demand literature (see, e.g., Hsieh & Lin, 1997; Kenkel, 1990). Also included are two dietary belief variables: the perceived importance of having at least two servings of milk, yogurt, or cheese products daily, and the perceived importance of using sugar in moderation. Both variables have a value ranging from 1 (not important) to 4 (very important). In addition, the numbers of children in four age categories are included: infant (under 1) and children aged 1–3, 4–6, and 7–10. Finally, dummy variables indicating race (Black, White) and residence in rural area are also used. The definitions and sample statistics for all variables are presented in Table 2.

Among the beverages considered, the percentages of consuming households are whole milk (70%), reduced-fat milk (31%), juice (75%), soft drink (82%), and coffee and tea

TABLE 2. Sample Statistics: Household Consumption of Beverages (Sample Size = 908)

Variable	Mean	Std. Dev.
Quantities (fl. oz./week)[a]		
Whole milk: full sample	115.20	143.07
Consuming households (69.9% of sample)	168.41	155.76
Reduced-fat milk (2%, 1%, skim): full sample	46.98	106.68
Consuming households (30.6% of sample)	157.19	153.65
Juice (100% fruit and vegetables): full sample	63.84	88.40
Consuming households (74.6% of sample)	85.62	92.83
Soft drink: full sample	129.68	159.91
Consuming households (81.8% of sample)	176.22	212.10
Coffee and tea: full sample	9.05	17.07
Consuming households (72.1% of sample)	12.54	18.97
Expenditure shares		
Whole milk	0.24	0.24
Reduced-fat milk	0.10	0.19
Juice (fruit and vegetable)	0.22	0.21
Soft drink	0.28	0.24
Coffee and tea	0.16	0.20
Prices (cents/fl. oz.)		
Whole milk	3.07	4.11
Reduced-fat milk	2.13	0.64
Juice (fruit and vegetable)	4.78	4.46
Soft drink	9.19	25.61
Coffee and tea	31.37	31.60
Household composition and demographics		
Infants, number of	0.09	0.29
Children 1–3, number of	0.28	0.53
Children 4–6, number of	0.33	0.59
Children 7–10, number of	0.31	0.62
Nutrition information		
Information: sum of information sources (paper, TV, etc.)	3.10	2.03
Dietary beliefs		
Dairy: perceived importance of having at least two servings of milk, yogurt, or cheese products daily (1–4)	1.64	0.83
Sugar: perceived importance of using sugar in moderation (1–4)	1.73	0.93
Dummy variables (yes = 1; no = 0)		
Black: household is Black	0.40	
White: household is White	0.44	
Rural: household resides in rural area	0.15	

Note. Source is National Food Stamp Program Survey (NFSPS), 1996–1997.
[a]Percentages of consuming households are milk (91%), juice (75%), soft drink (82%), and coffee and tea (72%).

(72%). Only 53 households (or about 6% of the sample) reported consumption of all five beverages during the sample period. A total of 343 households reported one zero, 360 reported two zeros, 119 reported three zeros, and 33 households reported four zeros among the beverages. Thus, about 3.6% of the households require evaluation of four-dimensional normal probabilities in the estimation.

5. RESULTS

The censored Translog demand system is estimated by maximizing the log-likelihood function. Asymptotic standard errors for the ML estimates are calculated from the heteroscedasticity-consistent covariance matrix (White, 1982). The results are presented in Table 3. Significance of the demographic variables is somewhat sparse, with slightly over one third of the coefficients significant at the 10% level or lower. Among the 15 quadratic-price coefficients (β_{ij}), 8 are significant. In addition, all of the error standard deviations and 4 of the 6 error correlation coefficients are significant. The lack of significance of some of the parameter estimates may be due to the small sample size.

Demand elasticities are calculated at the sample means of explanatory variables. Also, for statistical inference, standard errors for elasticities are calculated by first-order Taylor-series approximation (Ruud, 2000, pp. 366–367). The uncompensated price and expenditure elasticities are presented in Table 4 (top). All own-price elasticities are negative and significant at the 1% level. Interestingly, the own-price elasticity for reduced-fat milk is greater (in absolute) than that for whole milk. Thus, demand for reduced-fat milk is elastic. Demands for all other beverages are inelastic, with own-price elasticities significantly less than unity. Among the 20 uncompensated cross-price elasticities, 10 are significant at the 1% level and two at the 5% level. The two cross-price elasticities between whole milk and reduced-fat milk are both positive and significant, suggesting that these two milk products are gross substitutes. All other significant cross-price elasticities are negative and suggest gross complementarity among the beverage products. Relative to all own-price effects and the cross-price effects between whole milk and reduced-fat milk, these negative cross-price effects are much less pronounced, the largest elasticity being -0.27. Note that while gross substitution exists between the two milk products, there is no evidence of such substitution between milk (whole and reduced-fat) and soft drink. In fact, some gross complementarity exists between milk, juice, and soft drink. In particular, juice and soft drink are gross complements for whole milk, as is whole milk for juice and soft drink. In short, relative prices alone do not fully explain the displacement of milk by soft drink. The own-price elasticities suggest that milk consumption can be promoted better by decreasing the prices of milk (particularly price of reduced-fat milk), and soft drink consumption curtailed by increasing the price of soft drink. All total (beverage) expenditure elasticities are positive, being significantly less than unity for whole milk, reduced-fat milk and juice, unity for soft drink and significantly greater than unity for coffee and tea. Assuming, legitimately, that total beverage is a normal good, these positive elasticities suggest that the beverage products are all normal goods. In sum, demand for all beverages is responsive to changes in own prices and total beverage expenditure. Cross-price effects are present but the magnitudes are small relative to expenditure and own-price effects.

Compensated price elasticities are calculated using the Slutsky equation and are presented in Table 4 (bottom). All compensated own-price elasticities are negative and significant at the 1% level but are smaller than their uncompensated counterparts in

TABLE 3. Maximum-Likelihood Estimates of Censored Translog Demand System

	Whole milk	Reduced-fat milk	Juice	Soft drink
Demographic variables (α_{ij})				
Constant	−0.253***	0.210***	−0.173***	−0.242***
	(0.051)	(0.053)	(0.043)	(0.046)
Information	0.004	−0.004	−0.008**	−0.004
	(0.003)	(0.004)	(0.003)	(0.004)
Dairy	−0.019**	−0.015	0.002	0.004
	(0.009)	(0.009)	(0.008)	(0.008)
Sugar	0.008	−0.009	−0.004	0.024***
	(0.007)	(0.008)	(0.007)	(0.007)
Infants	−0.005	0.012	−0.075***	0.005
	(0.022)	(0.027)	(0.028)	(0.024)
Children 1–3	−0.050***	0.016	−0.036***	−0.005
	(0.011)	(0.016)	(0.013)	(0.011)
Children 4–6	−0.018	−0.020	0.001	−0.037***
	(0.013)	(0.016)	(0.010)	(0.012)
Children 7–10	−0.025**	0.019	−0.008	−0.003
	(0.012)	(0.013)	(0.010)	(0.010)
Black	0.014	−0.009	0.024	−0.061***
	(0.020)	(0.025)	(0.023)	(0.023)
White	0.030	−0.081***	0.067***	−0.003
	(0.019)	(0.023)	(0.024)	(0.017)
Rural	0.046**	−0.029	0.014	0.020
	(0.023)	(0.021)	(0.016)	(0.017)
Quadratic price terms (β_{ij})				
Whole milk	−0.048**			
	(0.023)			
Reduced-fat milk	−0.075**	0.048*		
	(0.034)	(0.028)		
Juice	0.039***	0.011	−0.096***	
	(0.008)	(0.010)	(0.012)	
Soft drink	0.018***	0.001	0.008	−0.053***
	(0.006)	(0.006)	(0.008)	(0.010)
Coffee and tea	0.032***	0.008	0.005	0.004
	(0.010)	(0.015)	(0.013)	(0.013)
Error standard deviations				
σ_i	0.246***	0.268***	0.273***	0.269***
	(0.011)	(0.021)	(0.008)	(0.009)
Error correlations (ρ_{ij})				
Reduced-fat milk	−0.686***			
	(0.055)			
Juice	−0.158***	−0.008		
	(0.039)	(0.043)		
Soft drink	−0.103**	−0.003	−0.254***	
	(0.043)	(0.041)	(0.036)	
Log-likelihood	−883.528			

Note. Asymptotic standard errors in parentheses. Levels of statistical significance: *** = 1%, ** = 5%, * = 10%. Parameter estimate for the own-price coefficients for coffee and tea ($\beta_{5,5}$) is -0.055 with a standard error of 0.066.

TABLE 4. Demand Elasticities[a]

	Whole milk	Reduced-fat milk	Juice	Soft drink	Coffee and tea	Total expend.
Uncompensated Elasticities						
Whole milk	−0.69***	0.50***	−0.27***	−0.13***	−0.22***	0.80***
	(0.17)	(0.20)	(0.06)	(0.05)	(0.05)	(0.10)
Reduced-fat milk	0.68**	−1.40***	−0.05	0.02	−0.06	0.81***
	(0.28)	(0.21)	(0.09)	(0.06)	(0.09)	(0.08)
Juice	−0.23***	−0.06	−0.52***	−0.06**	−0.03	0.90***
	(0.04)	(0.05)	(0.05)	(0.03)	(0.04)	(0.04)
Soft drink	−0.11***	−0.01	−0.07***	−0.80***	−0.02	1.01***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.05)	(0.04)
Coffee and tea	0.01	−0.07***	−0.10***	−0.08***	−0.89***	1.13***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.05)
Compensated Elasticities						
Whole milk	−0.59***	0.54***	−0.12***	0.09***	0.08	
	(0.19)	(0.20)	(0.05)	(0.03)	(0.05)	
Reduced-fat milk	0.78***	−1.36***	0.10	0.24***	0.24***	
	(0.27)	(0.21)	(0.09)	(0.06)	(0.08)	
Juice	−0.12***	−0.02	−0.35***	0.19***	0.31***	
	(0.04)	(0.05)	(0.05)	(0.03)	(0.04)	
Soft drink	0.01	0.04	0.12***	−0.52***	0.35***	
	(0.02)	(0.04)	(0.03)	(0.05)	(0.06)	
Coffee & tea	0.14***	−0.02	0.12***	0.22***	−0.47***	
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	

Note. Asymptotic standard errors in parentheses. Levels of statistical significance: *** = 1%, ** = 5%.

magnitudes. With two exceptions (between whole milk and juice), all other compensated cross-price effects are positive. Thus, unlike the uncompensated cross-price elasticities, which suggest net complementarity, these compensated elasticities suggest that net substitution is the obvious pattern among the beverage products. Most importantly, the compensated elasticities suggest whole milk, reduced-fat milk, juice and coffee and tea are all net substitutes for soft drink.

In Table 5, we compare our own-price and expenditure elasticities for whole milk and reduced-fat milk with those reported in the literature. Relative to findings by Gould (1996), which are also based on a censored Translog demand system, our expenditure elasticities for both milk products are slightly lower, whereas our own-price elasticity for reduced-fat milk is much higher. Our expenditure elasticity for whole milk is slightly higher, and the expenditure elasticity for reduced-fat milk is notably higher than the elasticities reported by Gould, Cox, and Perali (1990), who reported an expenditure elasticity of 0.06 (insignificant) for reduced-fat milk. Without an income elasticity for total beverage, it is hard to compare our expenditure elasticities with some of the income elasticities reported in the literature. However, our expenditure elasticity for reduced-fat milk is much lower than the income elasticities reported by Schmit, Dong, Chung, Kaiser, and Gould (2002), Cornick, Cox, and Gould (1994), Gould et al. (1990), Rauniker and Huang (1984), and Blaylock and Smallwood (1993). More interestingly, while we join Gould (1996), Gould et al. (1990), and Huang and Rauniker (1983) in suggesting that whole milk is a normal

TABLE 5. Comparison of Marshallian Own-Price and Expenditure or Income Elasticities

	Whole milk		Reduced-fat milk	
Commodity	Own-price	Expenditure	Own-price	Expenditure
This study	−0.69	0.80	−1.40	0.81
Gould (1996)	−0.80	1.01	−0.51–−0.59	0.98–1.01
Schmit et al. (2002)	−2.32	−0.40	−0.62–−1.49	0.01–0.41
Cornick et al. (1994)		−0.17		0.02–0.21
Gould et al. (1990)		0.66		0.06
Rauniker and Huang (1984)		−0.18		0.35
Huang and Rauniker (1983)		0.32		
Blaylock and Smallwood (1993)		−0.13		0.26

Note. Results by Gould (1996) and Gould et al. (1990) were based on demand system estimates and the partial elasticities are more comparable to those of the current studies. All other estimates are based on single-equation estimates and, therefore, the elasticities under column "expenditure"are income elasticities.

good (assuming, legitimately, that aggregate beverage is a normal good), the rest of the aforementioned literature suggests that whole milk is an inferior good.

The elasticities with respect to nutrition information, dietary belief, and demographic variables are presented in Table 6. The results suggest nutrition information and dietary beliefs do play important roles in beverage consumption. According to these elasticities, nutrition information has a positive effect on consumption of juice but a negative effect on coffee and tea. Belief in the importance of dairy products has positive effects on the consumption of both whole milk and reduced-fat milk, but a negative effect on coffee and tea. As expected, the perceived importance of using sugar in moderation works against consumption of soft drink but has no effect on consumption of all other beverage products. These results suggest that nutrition educational programs and advertising campaigns about sugar and dairy product intakes can be effective in promoting milk consumption and curtailing soft drink consumption. The effects of household composition are mixed. The number of infants has a positive effect only in juice, number of children 1–3 increases consumption of whole milk and juice but decreases the consumption of coffee and tea. The number of children 4–6 increases the consumption of soft drink but decreases the consumption of coffee and tea. The number of school-age children (7–10) increases only the consumption of whole milk.

TABLE 6. Demographic Elasticities

					Children					
	Information	Dairy	Sugar	Infants	1–3	4–6	7–10	Black	White	Rural
Whole milk	−0.08	0.43**	−0.17	0.00	0.09***	0.04	0.05**	−0.04	−0.09	−0.05**
	(0.06)	(0.20)	(0.16)	(0.01)	(0.02)	(0.03)	(0.02)	(0.05)	(0.06)	(0.02)
Reduced-fat milk	0.12	0.43*	0.25	−0.01	−0.04	0.06	−0.05	0.03	0.31***	0.04
	(0.10)	(0.26)	(0.22)	(0.02)	(0.04)	(0.04)	(0.04)	(0.09)	(0.09)	(0.03)
Juice	0.12**	−0.03	0.07	0.03***	0.05***	0.00	0.01	−0.05	−0.15***	−0.01
	(0.05)	(0.14)	(0.12)	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.05)	(0.01)
Soft drink	0.06	−0.05	−0.34***	0.00	0.01	0.05***	0.00	0.10***	0.01	−0.01
	(0.05)	(0.12)	(0.10)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
Coffee and tea	−0.07***	−0.18**	0.12	−0.01	−0.04***	−0.05***	−0.01	−0.02	0.01	0.01**
	(0.03)	(0.08)	(0.09)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.01)

Note. Asymptotic standard errors in parentheses. Levels of statistical significance: *** = 1%, ** = 5%, * = 10%.

Also presented in Table 5 are the elasticities with respect to dummy variables. Although elasticities with respect to binary variables are not strictly correct, evaluated at sample means of variables, these elasticities nevertheless serve as convenient indicators of the directions and statistical significance of their effects on consumption. Black has a positive effect on soft drink consumption, while White has a positive effect on reduced-fat milk but negative effect on juice. Relative to households in urban areas, those residing in rural areas consume less whole milk but more coffee and tea. In sum, household characteristics do play significant roles in beverage consumption.

6. CONCLUDING REMARKS

Declining consumption of milk and increasing consumption of soft drink are important public policy concerns in the United States. The increasing popularity of fast food in the American diet and the proliferation of vending machines in schools are currently considered two major contributors to the rising supply of carbonated soft drink. Recognizing the nutritional consequences of displacing milk consumption by soft drink consumption, legislators at both the national and state levels are proposing bills to restrict access to soft drink and nutrition-poor snacks in schools (Nutrition Week, 2001). The State of California Legislature, for instance, recently passed a bill, banning sale of soft drink all day in elementary schools and before and during lunch in middle schools (California State Senate, 2001).

While the public has been focusing on regulatory measures to curtail soft drink consumption, this study adds to existing literature on the effects of socio-demographic factors and also examines the role of economic factors, nutrition information, and dietary beliefs in beverage consumption. Motivated by the increasing trend in the (relative) price of milk sold for at-home use and declining trend in its consumption (relative to soft drink), we investigate the roles of prices by estimating a system of beverage consumption equations. The system approach also allows examination of the effects of nonprice factors such as nutrition information, dietary beliefs, and demographic characteristics. While we find no direct evidence of gross substitution between milk and soft drink, whole milk, reduced-fat milk, juice, and coffee and tea are all net substitutes for soft drink after income effects are accommodated. Thus, prices do provide a partial answer to the displacement of milk by soft drink. At-home demand for milk (especially reduced-fat milk) is found to be price responsive, as is demand for soft drink. These own-price responses suggest price interventions can be effective tools in promoting milk consumption for home use and curtailing soft drink consumption. Our findings on the roles of nutrition information and dietary beliefs provide evidence that nutrition educational programs and advertising campaigns addressing the benefits of dairy products and calcium intakes may have been effective in promoting milk consumption at home and curtailing soft drink consumption. One would expect that purchases of milk and soft drinks for away-from-home consumption would exhibit similar price responsiveness and informational effects, but we currently lack data to directly test this supposition.

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